

Photo-induced Insulator-to-metal Transition in VO₂ probed by Femtosecond X-ray Absorption

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We investigate the physics of phase transitions in non-magnetic oxides, where strong correlations between electronic and structural degrees of freedom cause large changes in the electrical and optical properties of the system across specific transition temperatures. In particular, we work on the case of VO₂, which undergoes an insulator-to-metal transition upon small structural distortion at 340 K¹. Because structural and electronic effects occur “simultaneously” in time-integrated measurements, the elementary mechanism driving the phase transition is difficult to establish. A phase transition from the insulating to the metallic state can be impulsively photo-induced, with both structural and electronic effects occurring on the sub-picosecond timescale².

We measure ultrafast changes in the NEXAFS spectrum during and after photo-excitation of the Low-T insulator. By comparing the changes at the V L_{3,2} edges and at the Oxygen K edge (510-550 eV) we seek to identify the characteristic timescales for the motion of different bands, thereby evidencing the responsible mechanism for the electronic transition. The measurement is conducted by using a flat-field soft x-ray spectrometer, recording the soft x-ray absorption spectrum for different laser x-ray time delays. The experiment is conducted by gating only those pulses of the ALS train that are overlapped with a femtosecond laser operating at 1 KHz. Ultimately, the experiments will be conducted with femtosecond synchrotron pulses as obtained with the laser-slicing technique.

REFERENCES

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